



**UNIVERSITI PUTRA MALAYSIA**

**EFFECTS OF NITROGEN FERTILIZATION LEVELS ON THE STRAW  
NUTRITIVE QUALITY OF MR 211 AND MR 219 RICE VARIETIES**

**HOLLENA ANAK NORI.**

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**By**

**HOLLENA ANAK NORI**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in  
Fulfillment of the Requirement for the Degree of Master of Science**

**July 2005**



## **DEDICATION**

**Dedicated to my family and friends  
for their understanding and inspiration**



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

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NUTRITIVE QUALITY OF MR 211 AND MR 219 RICE VARIETIES**

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**HOLLENA NORI**

**July 2005**

**Chairman: Associate Professor Mohd Ridzwan Abdul Halim, PhD**

**Faculty : Agriculture**

Rice straw has been used as ruminant feed in many Asean countries although it is regarded as poor quality feed due to its low protein concentration and digestibility. It has been reported that the nutritive quality of rice straw varies among different varieties and is affected by environmental condition that determines its growth pattern. In view of the reports on the environmental effect on straw quality, this study was designed to evaluate the nutritive quality of rice straw with increasing application of nitrogen fertilizer.

Samples of rice straw from two varieties, MR 211 and MR 219 which were grown under five levels of nitrogen fertilizer (0, 120, 160, 200 and 240 kg N/ha) were harvested and analyzed for chemical composition and digestibility. The results showed that the straw nutritive quality was improved with nitrogen application.

Increases in the level of nitrogen fertilization were found to increase the straw crude protein significantly. The maximum nitrogen level at 240 kg N/ha was found to produce crude protein of 8.45%, which is above the level required for ruminant feed. The straw cell wall (NDF) and fiber (ADF) fraction were found to decrease significantly with nitrogen application. The organic matter digestibility was slightly lowered with increasing nitrogen level. The concentration of hemicellulose, cellulose, lignin (ADL), silica, organic matter, ash and the dry matter digestibility were not affected by the nitrogen fertilization level. In the agronomic characteristics and yield components, the level of nitrogen was shown to increase the tiller numbers, stem height, maturity, number of spikelets per panicle, total spikelets per square meter, grain and straw yield and total yield.

There were significant varietal differences in the concentration of cell wall (NDF), hemicellulose, cellulose, lignin (ADL) and silica in rice straw, where MR 219 had higher cell wall (NDF), hemicellulose and cellulose concentration where as MR 211 had higher amount of lignin (ADL) and silica in the straw. In the agronomic characteristics, MR 219 had higher number of tillers per plant, total panicles per square meter, total spikelets per square meter, grain yield, total yield and grain: straw ratio where as MR 211 had shorter stem height, maturity period and higher leaf: stem ratio. Both varieties were shown to produce straw with improved nutritive quality. In comparison between the two varieties, MR 219 is superior to MR 211 in view of its higher grain yield and grain: straw ratio.

The grain and straw yield were positively correlated with the straw crude protein and digestibility and negatively correlated with the cell wall (NDF) and fiber (ADF) fraction.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**KESAN KADAR PEMBAJAAN NITROGEN KE ATAS KUALITI PEMAKANAN  
PADA JERAMI PADI VARIETI MR 211 DAN MR 219**

Oleh

**HOLLENA NORI**

**Julai 2005**

**Pengerusi: Professor Madya Mohd Ridzwan Abdul Halim, PhD**

**Fakulti : Pertanian**

Jerami padi telah digunakan sebagai makanan ruminan di kebanyakan negara Asean meskipun ia dianggap sebagai makanan berkualiti rendah disebabkan oleh kandungan protein serta kadar pencernaannya yang rendah. Terdapat laporan mengatakan bahawa kualiti pemakanan pada jerami padi adalah berbeza mengikut varieti dan dipengaruhi oleh faktor persekitaran yang mempengaruhi pertumbuhannya. Memandangkan terdapat laporan mengenai kesan persekitaran ke atas kualiti jerami, kajian ini dilakukan untuk menilai kualiti pemakanan pada jerami padi dengan penggunaan baja nitrogen yang tinggi.

Sampel jerami padi daripada dua varieti, MR 211 dan MR 219 yang ditanam di bawah lima kadar pembajaan nitrogen (0, 120, 160, 200 dan 240 kg N/ha) telah dituai dan dianalisis untuk kandungan kimia dan pencernaan. Keputusan menunjukkan bahawa kualiti pemakanan pada jerami telah bertambah baik dengan pembajaan nitrogen.

Peningkatan penggunaan baja nitrogen didapati telah meningkatkan kandungan protein kasar di dalam jerami. Penggunaan baja nitrogen pada kadar maksimum 240 kg N/ha didapati menghasilkan protein kasar sebanyak 8.45%, iaitu memenuhi keperluan untuk makanan ruminan. Kandungan sel dinding (NDF) dan serat (ADF) didapati menurun serta kadar pencernaan bahan organik menurun sedikit dengan penggunaan baja nitrogen. Kandungan hemiselulosa, selulosa, lignin (ADL), silika, bahan organik, abu dan kadar pencernaan bahan kering didapati tidak dipengaruhi oleh kadar pembajaan nitrogen. Dalam ciri agronomi serta komponen hasil, kadar pembajaan nitrogen telah meningkatkan bilangan daun, ketinggian batang, umur matang, bilangan biji setangkai, jumlah biji semeter persegi, hasil padi dan jerami serta hasil keseluruhan.

Terdapat perbezaan yang signifikan di antara varieti di dalam kandungan sel dinding (NDF), hemiselulosa, selulosa, lignin (ADL) dan silika, di mana MR 219 mempunyai kandungan sel dinding (NDF), hemiselulosa dan selulosa yang lebih tinggi manakala MR 211 mempunyai kandungan lignin (ADL) dan silika yang lebih tinggi. Dalam ciri-ciri agronomi, MR 219 mempunyai bilangan daun sepokok, jumlah tangkai semeter persegi, jumlah biji semeter persegi, hasil padi, hasil keseluruhan dan nisbah padi: jerami yang lebih tinggi manakala MR 211 mempunyai batang lebih pendek, umur matang yang



singkat serta nisbah daun: batang yang lebih tinggi. Kedua-dua varieti didapati menghasilkan jerami dengan kualiti pemakanan yang lebih baik. Dalam perbandingan di antara kedua-dua varieti, MR 219 adalah lebih baik berbanding MR 211 kerana mempunyai hasil padi dan nisbah padi: jerami yang lebih tinggi.

Hasil padi dan jerami didapati berkorelasi secara positif dengan kandungan protein kasar dan kadar pencernaan jerami serta berkorelasi secara negatif dengan kandungan sel dinding (NDF) dan serat (ADF).

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I certify that an Examination Committee met on 6<sup>th</sup> July 2005 to conduct the final examination of Hollena Anak Nori on her Master of Science thesis entitled “Effects of Nitrogen Fertilization Levels on the Straw Nutritive Quality of MR 211 and MR 219 Rice Varieties” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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## DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.



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**HOLLENA ANAK NORI**

Date: 15 AUGUST 2005

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## LIST OF ABBREVIATIONS

ADF	Acid Detergent Fiber
ADL	Acid Detergent Lignin
ADS	Acid Detergent Solution
ANOVA	Analysis of Variance
AOAC	Association of Official Analytical Chemists
ATP	Adenosine Triphosphate
$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$	Calcium Chloride
CEC	Cation Exchange Capacity
$\text{CH}_4$	Methane
C/N	Carbon to Nitrogen Ratio
$\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$	Cobalt Chloride
$\text{CO}(\text{NH}_2)_2$	Urea
CP	Crude Protein
CRD	Completely Randomized Design
CTAB	Cetyl trimethylammonium bromide
C.V.	Coefficient of Variance
DAS	Days After Sowing
D.F.	Degrees of Freedom
DM	Dry Matter
DMI	Dry Matter Intake
DNA	Deoxyribonucleic acid

EDTA	Disodium Ethylenediaminetetraacetate
et al.	and friends
$\text{FeCl}_2 \cdot 6\text{H}_2\text{O}$	Iron Chloride
HCl	Hydrochloric Acid
$\text{H}_3\text{PO}_4$	Phosphoric Acid
$\text{H}_2\text{SO}_4$	Sulphuric Acid
IVD	<i>In Vitro</i> Digestibility
IVDMD	<i>In Vitro</i> Dry Matter Digestibility
IVOMD	<i>In Vitro</i> Organic Matter Digestibility
IVTDMD	<i>In Vitro</i> True Dry Matter Digestibility
IVTOMD	<i>In Vitro</i> True Organic Matter Digestibility
$\text{K}_2\text{Cr}_2\text{O}_7$	Potassium Dichromate
$\text{KH}_2\text{PO}_4$	Potassium Dihydrogen Phosphate
$\text{K}_2\text{O}$	Dipotassium Oxide
$\text{K}_2\text{SO}_4$	Potassium Sulphate
LAI	Leaf Area index
L.S.D.	Least Significant Difference
MARDI	Malaysian Agriculture Research and Development Institute
$\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$	Magnesium Sulphate
$\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$	Manganese Chloride
MOP	Muriate of Potash
N	Normality
$\text{NaHCO}_3$	Sodium Hydrogen Carbonate

$\text{Na}_2\text{HPO}_4$	Disodium Hydrogen Phosphate
$\text{NaOH}$	Sodium Hydroxide
$\text{Na}_2\text{S} \cdot 7\text{H}_2\text{O}$	Sodium Sulphite
$\text{Na}_2\text{S}_2\text{O}_3$	Sodium Thiosulphate
NDF	Neutral Detergent Fiber
NDS	Neutral Detergent Solution
$\text{NH}_3$	Ammonia
$\text{NH}_4^+$	Ammonium ion
$\text{NH}_4\text{F}$	Ammonium Flouride
$(\text{NH}_4)\text{HCO}_3$	Ammonium Hydrogen Carbonate
$\text{NH}_4\text{OAc}$	Ammonium Acetate
$\text{NO}_2$	Nitrogen dioxide
PE	Polyethylene
$\text{P}_2\text{O}_5$	Diphosphate Pentaoxide
RNA	Ribonucleic Acid
SAS	Statistical Analysis Software
S.D.	Standard Deviation
S.E.	Standard Error
sp.	Species
SPAD	Specific Photosynthesis Analyzer Detector
TSP	Triple Super Phosphate



## **CHAPTER 1**

### **INTRODUCTION**

Rice is the staple food for Malaysians. As population increases, there is need to increase the rice grain production to enhance food security. The target of the Ministry of Agriculture and Agro-based Industry Malaysia is to increase the rice grain yield from current average yield of 4.5 t/ha to 10 t/ha (MOA, 2004a). Among the steps that have been taken to achieve this target is the application of high levels of nitrogen fertilizer. Farmers are currently applying more than the recommended rate of 170 kg N/ha as they believe that higher nitrogen levels are essential in maximizing grain yields (Alias and Manaf, 1993).

In Malaysia, the rice breeding research has been focusing on improving the agronomic characteristics such as grain yield and quality. Research has generally concentrated on the importance of nitrogen in increasing the grain yield and the effects of nitrogen on the straw yield and quality have not been investigated.

The 684 000 hectares of rice fields in Malaysia produced 1.3 million tonnes of rice straw annually (MOA, 2004b). The burning of rice straw and stubble in Malaysian rice field still remain as cultural and current practice of its disposal. Since large amount of straw produced is disposed by burning which is not only wasting resources but also causing